

INDOOR AIR QUALITY ASSESSMENT

**J.W. Martin Elementary School
9 Landry Avenue
North Attleborough, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
August 2005

Background/Introduction

At the request of Richard Smith, Superintendent, North Attleborough Public Schools (NAPS), the Massachusetts Department of Public Health's (MDPH), Center for Environmental Health (CEH), provided assistance and consultation regarding indoor air quality in all of North Attleborough's public schools. These assessments were coordinated through Roland Deneault, Facilities Director for NAPS. On March 24, 2005, Cory Holmes an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program conducted an indoor air quality assessment at the Martin Elementary School (MES) located at 9 Landry Ave, North Attleborough, MA.

The MES is a one-story red brick building that was constructed in 1967. An addition was built in 1995. The majority of building materials in the 1967 portion of the building appeared to be original (e.g., floor tiles, heating and ventilation components, window systems). This wing also has a history of roof leaks. Mr. Deneault reported that a new roof was on a capital improvement list and is tentatively scheduled to be installed during the 2005-2006 school year. Windows throughout the building are openable.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-TRAK™ IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo

Ionization Detector (PID). MDPH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 665 students in grades kindergarten through fifth with a staff of approximately 60. Tests were taken under normal operating conditions and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) parts of air in eighteen of forty areas surveyed, indicating inadequate air exchange in a number of areas, primarily in the 1967 portion of the building. Fresh air in classrooms is supplied by a unit ventilator (univent) system (Picture 1). Univents are designed to draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 2) and return air through an air intake located at the base of each unit ([Figure 1](#)). Fresh and return air are mixed and filtered, then heated and provided to classrooms through an air diffuser located in the top of the unit. Univents did not appear to run continuously but rather were activated by thermostats. Univents are activated once room temperatures drop below a set level. When the room temperature exceeds the thermostat setting, univents deactivate. Therefore, no mechanical ventilation is provided until the thermostat re-activates the system. Obstructions to airflow, such as papers and books stored on univents and bookcases, carts and desks in front of univent returns, were seen in several

classrooms. In order for univents to provide fresh air as designed, units must remain free of obstructions.

Mechanical exhaust ventilation in classrooms is provided by unit exhaust ventilators. A unit exhaust ventilator appears similar to a univent, but removes air from the classroom and exhausts it out of the building. As with the univents, unit exhaust ventilators appeared to be operating intermittently during the assessment. Without sufficient supply and exhaust ventilation, normally occurring environmental pollutants can build-up and lead to indoor air quality/comfort complaints.

Mechanical ventilation for interior rooms is provided by rooftop air handling units (AHUs). Fresh air is distributed to the classroom via ductwork connected to ceiling-mounted air diffusers. Return vents draw air back to the AHUs through wall or ceiling-mounted grilles (Pictures 4 and 5). The cafeteria is designed to be ventilated by two ceiling-mounted AHUs (Picture 6) that were not operating during the assessment.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a univent and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room

is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools because a majority of occupants is young and considered a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information on carbon dioxide see [Appendix A](#).

Temperature readings ranged from 69° F to 74° F, which were within or very close to the lower end of the MDPH recommended comfort guidelines during the assessment. The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air.

The relative humidity measurements ranged from 24 to 40 percent, which were below or slightly below the lower end of the MDPH recommended comfort range in the majority of areas surveyed. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity would be expected to drop below comfort levels during the heating season. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

The building has a history of roof leaks and water damage. As discussed, a new roof is on a capital repair list and scheduled to be installed during the 2005-2006 school year, along with new ceiling tile systems in many classrooms. Water damaged ceiling tiles were observed in a number of areas throughout the building. Water-damaged ceiling tiles can provide a source of mold growth and should be replaced after a water leak is discovered and repaired.

Spaces between the sink countertop and backsplash were seen in several classrooms (Table 1/Picture 7). Improper drainage or sink overflow can lead to water penetration of countertop wood, the cabinet interior and behind cabinets. Like other porous materials, if these materials become wet repeatedly they can provide a medium for mold growth.

Plants were noted in several classrooms. Plants can be a source of pollen and mold, which can be respiratory irritants for some individuals. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from univents to prevent the aerosolization of dirt, pollen or mold (Picture 8).

During the assessment a dehumidifier was observed in the computer lab draining into a trash barrel (Picture 9). A musty odor was detected from the barrel. The source appeared to be wet rags in standing water at the bottom of the barrel (Picture 10). As discussed wet porous materials can provide a medium for mold growth and associated odors.

Several areas were observed on the exterior of the building where mortar around brick was missing and/or damaged (Pictures 11 and 12). Repeated water penetration can result in the chronic wetting of building materials and potentially lead to microbial growth. In addition, cracks/holes in exterior walls may provide a means of egress for pests/rodents into the building.

Other IAQ Evaluations

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants; however, the pollutant produced is dependent on the material combusted. Common combustion products include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM_{2.5}) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, MDPH staff obtained measurements for carbon monoxide and PM_{2.5}.

Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide

level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient-Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000).

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. *Carbon monoxide should not be present in a typical, indoor environment.* If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect or ND (Table 1). Carbon monoxide levels measured in the school were also ND (Table 1).

The NAAQS originally established exposure limits for particulate matter with a diameter of 10 μm or less (PM₁₀). According to the NAAQS, PM₁₀ levels should not exceed 150 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in a 24-hour average. This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code,

US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM_{2.5} standard requires outdoor air particulate levels be maintained below 65 µg/m³ over a 24-hour average. Although both the ASHRAE standard and BOCA Code adopted the PM₁₀ standard for evaluating air quality, BEHA uses the more protective proposed PM_{2.5} standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM_{2.5} concentrations were measured at 13 µg/m³ (Table 1). PM_{2.5} levels measured indoors ranged from 8 to 24 µg/m³ (Table 1). Although PM_{2.5} measurements were above background in some areas, they were below the NAAQS of 65 µg/m³. Frequently, indoor air levels of particulates (including PM_{2.5}) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC

concentrations were ND (Table 1). Indoor TVOC measurements throughout the building were also ND (Table 1).

Please note, that the TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. While no measure able TVOC levels were detected in the indoor environment, VOC-containing materials were noted. Several classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat. Cleaning products were found on countertops and beneath sinks in a number of classrooms (Picture 13). Cleaning products contain VOCs and other chemicals, which can be irritating to the eyes, nose and throat and should be stored properly and kept out of reach of students.

Several areas contain photocopiers and lamination machines. Lamination machines can produce irritating odors during use. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). The teacher's workroom is equipped with local exhaust ventilation to help reduce excess heat and odors; however no draw of air was detected from the vent during the assessment. In addition, the door was pegged open, which allows odors to migrate into the main corridor where then can be distributed to other areas of the building.

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to

accumulate. These items, (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

Finally, in an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 14). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and off-gas TVOCs. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as [Appendix B](#) (NIOSH, 1998).

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Continue with plans for roof and ceiling tile systems replacement. Once completed repair/replace any remaining water-stained ceiling tiles and other building materials. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
2. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a

heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers.

3. Operate all ventilation systems that are operable throughout the building (e.g., cafeteria, classrooms) *continuously* during periods of school occupancy and independent of thermostat control. To increase airflow in classrooms, set univent controls to “high”.
4. Inspect exhaust motors and belts for proper function. Repair and replace as necessary.
5. Remove all blockages from univents and exhaust vents to ensure adequate airflow.
6. Use openable windows in conjunction with classroom univents and exhaust vents to increase air exchange. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.
7. Consider having ventilation systems re-balanced/calibrated every five years by an HVAC engineering firm.
8. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

9. Move plants away from univents in classrooms. Avoid over-watering and examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.
10. Contact a masonry firm or general contractor to repair holes/breaches in exterior walls to prevent water penetration, drafts and pest entry.
11. Empty barrel used to drain dehumidifier regularly to prevent standing water, mold growth and associated odors. Clean and disinfect with an appropriate anti-microbial as needed.
12. Seal areas around sinks to prevent water-damage to the interior of cabinets and adjacent wallboard. Inspect wallboard for water damage and mold growth, repair/replace as necessary. Disinfect areas with an appropriate antimicrobial, as needed.
13. Change filters for air-handling equipment (i.e., univents, AHUs, window mounted ACs) as per the manufacturer's instructions or more frequently if needed. Vacuum interior of units prior to activation to prevent the aerosolization of dirt, dust and particulates. Ensure filters fit flush in their racks with no spaces in between allowing bypass of unfiltered air into the unit.
14. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
15. Store cleaning products properly and out of reach of students.
16. Consider discontinuing the use of tennis balls on chairs to prevent latex dust generation.

17. Ensure local exhaust in photocopier room is activated, make repairs as needed. Keep door to photocopier room closed to contain heat and odors.
18. Consider adopting the US EPA document, “Tools for Schools”, to maintain a good indoor air quality environment on the building (USEPA, 200b). This document can be downloaded from the Internet at: <http://www.epa.gov/iaq/schools/index.html>.
19. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH’s website at <http://www.state.ma.us/dph/beha/iaq/iaqhome.htm>.

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Picture 1



Classroom Univent in Cabinet, Diffuser along Windowsill

Picture 2



Univent Fresh Air Intakes

Picture 3



Classroom Univent Obstructe4d by Various Items

Picture 4



Ceiling-Mounted Supply Vent

Picture 5



Ceiling-Mounted Return Vent

Picture 6



Ceiling-Mounted AHUs in Cafeteria

Picture 7



Spaces between Sink Countertop and Backsplash

Picture 8



Plants Hanging over Classroom Univent

Picture 9



Dehumidifier Emptying into Trash Barrel

Picture 10



Wet Rags and Standing Water in Bottom of Barrel in Preceding Picture

Picture 11



Missing/Damaged Mortar around Exterior Brick

Picture 12



Missing/Damaged Mortar around Exterior Brick

Picture 13



Spray Cleaning Products under Sink in Classroom

Picture 14



Tennis Balls on Chair Legs

Joseph W. Martin Elementary School
9 Landry Avenue, North Attleborough, MA
Indoor Air Results
March 24, 2005
Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
background	0	46	44	374	ND	ND	13	N # open: 0 # total: 0			Light rain, winds ENE 10-15 mph, wood stove odors.
1	23	69	40	926	ND	ND	13	Y # open: 0 # total: 4	Y univent	Y wall	Hallway DO, DEM, TB.
3	17	70	37	1069	ND	ND	10	N # open: 0 # total: 4	Y items	Y wall	Hallway DO, #WD-CT: 2, DEM, TB.
5	21	72	35	1130	ND	ND	19	Y # open: 0 # total: 4	Y univent items furniture plant(s)	Y wall	TB, plants.
7	0	70	30	829	ND	ND	8	Y # open: 0 # total: 4	Y univent furniture	Y wall	DEM, cleaners, pets, plants, occupants at gym.

ppm = parts per million

µg/m3 = micrograms per cubic meter

AD = air deodorizer

AP = air purifier

aqua. = aquarium

AT = ajar ceiling tile

BD = backdraft

CD = chalk dust

CP = ceiling plaster

CT = ceiling tile

DEM = dry erase materials

design = proximity to door

FC = food container

G = gravity

GW = gypsum wallboard

M = mechanical

MT = missing ceiling tile

NC = non-carpeted

ND = non detect

PC = photocopier

PF = personal fan

plug-in = plug-in air freshener

PS = pencil shavings

sci. chem. = science chemicals

TB = tennis balls

terra. = terrarium

UF = upholstered furniture

WD = water damage

WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Table 1-1

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
6	23	72	33	1305	ND	ND	11	Y # open: 0 # total: 4	Y univent	Y wall	
4	11	72	30	1138	ND	ND	17	Y # open: 0 # total: 4	Y univent items	Y wall	Hallway DO, #WD-CT: 5, DEM, plants.
2	22	72	31	1187	ND	ND	9	Y # open: 0 # total: 4	Y univent items	Y wall	#WD-CT: 1, DEM, TB.
computer lab	0	73	26	478	ND	ND	9	Y # open: 0 # total: 4	Y univent	Y wall	window-mounted AC, DEM.
29	22	70	27	832	ND	ND	9	Y # open: 0 # total: 4	Y univent	Y wall	TB.

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									Supply	Exhaust	
9	16	71	30	1207	ND	ND	14	Y # open: 0 # total: 4	Y		Hallway DO, DEM, TB.
11	18	72	31	1313	ND	ND	12	Y # open: 0 # total: 4	Y univent	Y wall	Hallway DO, DEM, TB.
12	20	73	30	1140	ND	ND	16	Y # open: 0 # total: 4	Y univent	Y wall	Hallway DO, DEM, TB.
13	24	74	31	1369	ND	ND	13	Y # open: 0 # total: 4	Y univent items	Y wall	Hallway DO, #WD-CT: 1, DEM, TB.
14	21	73	30	1115	ND	ND	10	Y # open: 0 # total: 4	Y univent items	Y wall items	Hallway DO, DEM, TB.

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									Supply	Exhaust	
10	12	72	29	1068	ND	ND	13	Y # open: 0 # total: 4	Y univent items	Y wall	Hallway DO, DEM, TB.
teachers workroom	2	74	27	633	ND	ND	11	N # open: 0 # total: 0	Y ceiling	Y ceiling (off)	Hallway DO, PC, laminator, strong odors, door kept open-odors in hallway, no draw from exhaust vent.
nurse	2	74	26	699	ND	ND	15	N # open: 0 # total: 0	Y ceiling	Y ceiling	Hallway DO,
8	21	71	30	1475	ND	ND	17	Y # open: 0 # total: 4	Y univent furniture	Y wall	#WD-CT: 5, TB.
reading room	6	73	26	758	ND	ND	10	N # open: 0 # total: 0	Y ceiling	Y ceiling	#WD-CT: 2, DEM, TB.

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									Supply	Exhaust	
library	25	71	24	555	ND	ND	11	Y # open: 0 # total: 0	Y univent	Y ceiling	Hallway DO,
computer lab	26	73	26	652	ND	ND	15	N # open: 0 # total: 0	Y ceiling	Y ceiling	Hallway DO, DEM, dehumidifier, dehumidifier-wet rags in barrel with standing water.
R-3	1	71	24	592	ND	ND	9	N # open: 0 # total: 0	Y ceiling	Y ceiling	CD, DEM, 3 occupants gone 20 min.
R-2	7	72	25	690	ND	ND	11	N # open: 0 # total: 0	Y ceiling	Y ceiling	DEM, TB, cleaners, cleaning prod/air fresh odors.
R-1	2	74	25	584	ND	ND	8	N # open: 0 # total: 0	Y ceiling	Y ceiling	DEM, TB.

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Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Joseph W. Martin Elementary School

9 Landry Avenue, North Attleborough, MA

Indoor Air Results

March 24, 2005

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
18	19	73	26	666	ND	ND	17	Y # open: 0 # total: 4	Y univent plant(s)	Y ceiling	Hallway DO, DEM, TB, plants, hanging plants over UV, plants on UV, plants on paper towels.
cafeteria/annex	150	73	31	1016	ND	ND	24	Y # open: 0 # total: 4	Y ceiling (off)	Y ceiling (off)	Hallway DO, 1 UV, 2 ceiling AHUs.
19	19	73	27	663	ND	ND	10	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM, TB, plants.
20	17	71	27	690	ND	ND	15	Y # open: 0 # total: 4	Y univent items	Y ceiling	Hallway DO, DEM, TB.
22	23	72	29	787	ND	ND	11	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM, TB.

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									Supply	Exhaust	
24	25	72	29	887	ND	ND	12	Y # open: 0 # total: 4	Y univent	Y ceiling	DEM, TB, pets.
25	23	72	27	751	ND	ND	13	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM, TB, plants.
23	25	72	29	892	ND	ND	12	Y # open: 0 # total: 4	Y univent	Y ceiling	breach sink/counter, TB.
21	10	74	26	655	ND	ND	12	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, breach sink/counter, DEM, TB.
K-3	15	73	26	628	ND	ND	15	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, breach sink/counter, DEM, TB.

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									Supply	Exhaust	
K-4	17	71	27	792	ND	ND	10	N # open: 0 # total: 0	Y univent	Y ceiling	breach sink/counter, DEM, TB.
K-5	19	73	28	794	ND	ND	13	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, #WD-CT: 1, breach sink/counter, DEM, TB, cleaners.
16	1	73	25	494	ND	ND	11	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM, TB, plants, 19 occupants gone 30 min, terrarium on UV.
15	21	74	26	687	ND	ND	11	Y # open: 0 # total: 4	Y univent		Hallway DO, DEM.
K-1	21	71	25	650	ND	ND	11	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM, TB.

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									Supply	Exhaust	
K-2	5	72	25	535	ND	ND	11	Y # open: 0 # total: 4	Y univent	Y ceiling	breach sink/counter, aqua/terra.

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